Office hrs: 9^{50} AM – 11^{50} AM
(Olin 127)

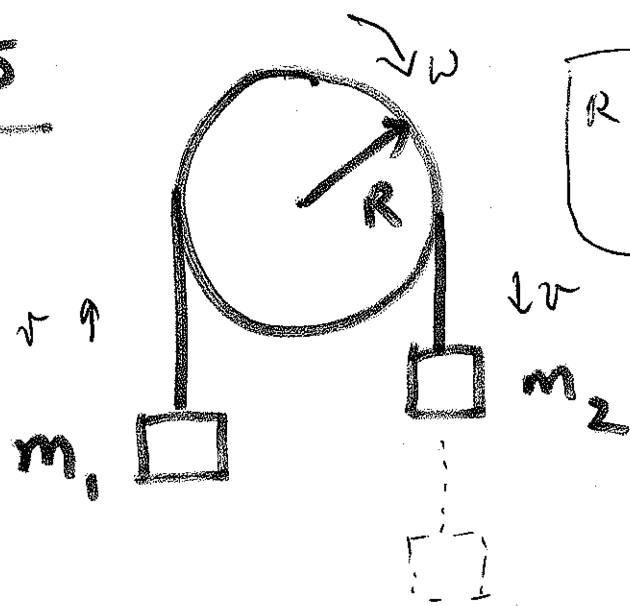
Monday: 9^{50} AM – 11^{50} AM

HW 5 due Wed, 10/7

Revisit 10-55

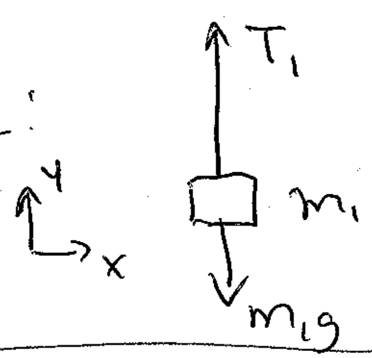
Rotational motion

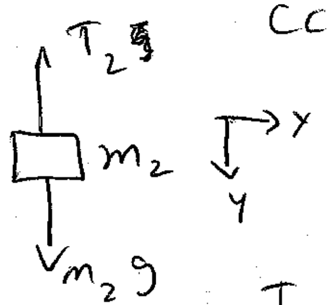
m_2 released from rest falls d meters in t seconds

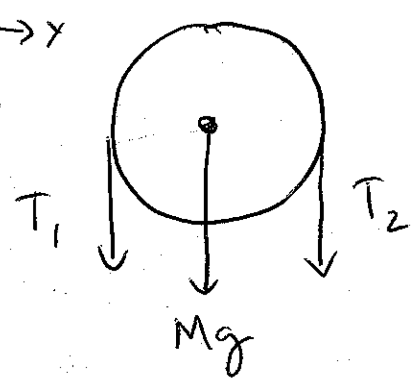


BC pulley rotates cw, let cw = + torque
ccw = − torque

FBD:







$\boxed{\Sigma F_{y_1} = T_1 - m_1 g = m_1 a}$

$\boxed{\Sigma F_{y_2} = m_2 g - T_2 = m_2 a}$

$\Sigma F_{y_{pulley}} = -T_1 - Mg - T_2$

$\tau = rF\sin\theta$

Torque for pulley $\Sigma\tau = -RT_1 \underbrace{\sin 90°}_{1} + RT_2 \sin 90° = I\alpha$

$\boxed{-RT_1 + RT_2 = I\alpha} \leftarrow \alpha = \frac{a}{R}$

Unknowns! T_1, T_2, I, a $\quad a = ?$

<u>Kinematics</u>: moves d meters in t seconds
starts from rest

$v = v_0 + at, \quad v^2 = v_0^2 + 2a(y - y_0)$

$y = y_0 + v_{0y}t + \frac{1}{2}at^2$

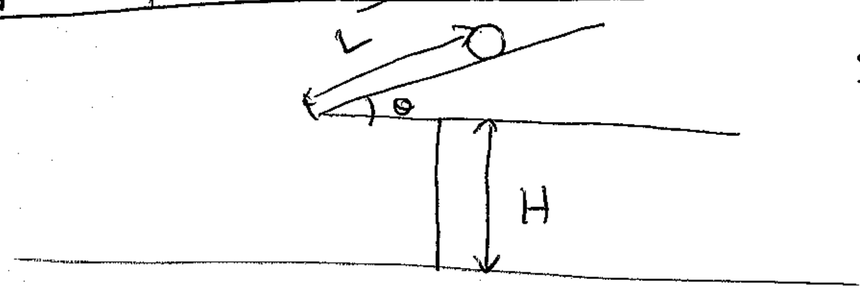
$y - y_0 = v_{0y}t + \frac{1}{2}at^2$

$d = 0 + \frac{1}{2}at^2 \Rightarrow$

$\boxed{a = \frac{2d}{t^2}}$

Example of rolling and friction

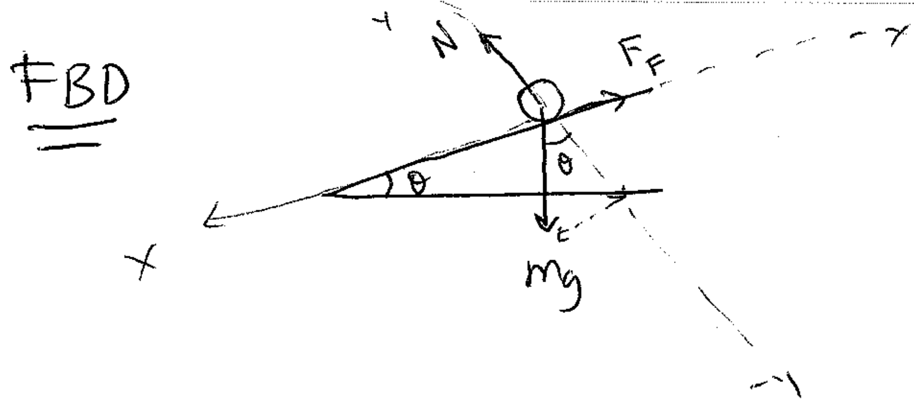
11-9.)



Solid cylinder
radius = R
mass = m
Starts from rest

rolls w/out slipping, roof inclined at angle θ

a.) $\omega = ?$ about center



↺ ccw = +
cw = −

$\mu = ?$

$$\Sigma F_y = N - mg\cos\theta = 0$$

$$\Sigma F_x = mg\sin\theta - F_F = ma$$

$$\Sigma \tau = F_F R = I\alpha = I\frac{a}{R} \qquad I = \frac{1}{2}MR^2$$

$$F_F \cancel{R} = \frac{1}{2}MR^{\cancel{2}}\cdot\frac{a}{\cancel{R}} = \frac{1}{2}M\cancel{R}a \Rightarrow F_F = \frac{1}{2}Ma$$

$$mg\sin\theta - \frac{1}{2}ma = ma \Rightarrow \cancel{m}g\sin\theta = \frac{3}{2}\cancel{m}a$$

$$a = \frac{2}{3}g\sin\theta \qquad \text{want } \omega$$

$$\alpha = \frac{a}{R} = \frac{2}{3}\frac{g\sin\theta}{R}$$

rotational Kinematics

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$

$$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$v^2 = 0 + 2\left(\frac{2}{3}g\sin\theta\right)(L) \Rightarrow v = \sqrt{\frac{4}{3}g\sin\theta L}$$

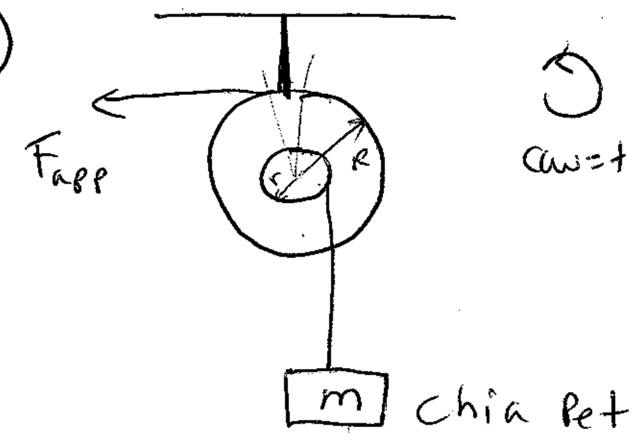
$$\omega = \frac{v}{R} = \frac{\sqrt{\frac{4}{3}g\sin\theta L}}{R}$$

c) $\mu = ?$

$$F_F = \frac{1}{2}ma = \frac{1}{2}m\left(\frac{2}{3}g\sin\theta\right)$$

From ΣF_y, $N = mg\cos\theta$ $\qquad F_F = \mu N$

10.96.)



cw = +

Outer radius = R

radius hub = r

Upward acceleration of a m/s^2

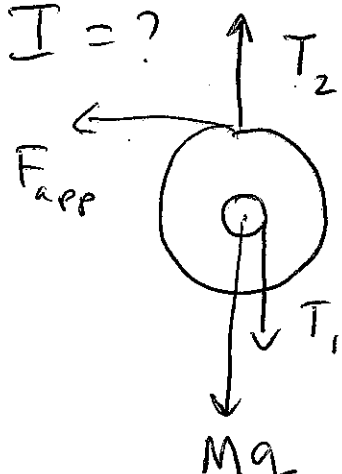
$I = ?$

$\uparrow y \rightarrow x$

$\Sigma F_y = T_1 - mg = ma$

$T_1 = mg + ma$

$T_1 = m(g+a)$

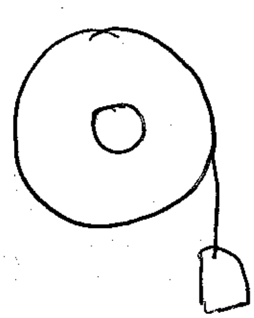


$$\Sigma \tau = +F_{app} R + \underbrace{\cancel{T_2(0)}}_{0} + \underbrace{\cancel{Mg(0)}}_{0} - T_1(r) = I\alpha$$

$$F_{app}(R) - m(g+a)r = I\frac{a}{r}$$

$$I = \frac{r}{a}\left[F_{app}(R) - m(g+a)r\right]$$

Check units



vs.